

1 REGULATED DASHPOT WITH SHOCK-ABSORPTION FORCE CONTROLS

2 The present invention concerns a regulated dashpot with shock-
3 absorption force controls, especially intended for motor
4 vehicles, as recited in the preamble to Claim 1.

5
6 Regulated hydraulic dashpots with flow-regulating system that
7 shift back and forth between compression and decompression phases
8 in operation are known. Dashpots of this genus are described in
9 German 3 803 838 C2 for instance.

10
11 There is a drawback to such dashpots in that their design permits
12 them to shift only suddenly between the hard and soft phases,
13 limiting the range of control. The comfortability of the ride can
14 be increased only to a limited extent.

15
16 The object of the present invention is accordingly a dashpot of
17 the aforesaid genus that can shift continuously between the hard
18 and soft phases, whereby the valve-adjustment intervals can be
19 varied at intervals that are not unnecessarily short or even
20 unattainable.

21
22 This object is attained by the characteristics recited in Claim
23 1. Advantageous and advanced embodiments are addressed in Claims
24 2 through 8.

25
26 The present invention has many advantages. A continuous
27 transition between hard and soft phases can be obtained by simple

1 means. Valve-adjustment intervals can be maintained long enough
2 to allow the device to be manufactured at justifiable component
3 costs and to be operated at low requisite adjustment powers.

4
5 One particular advantage is that the flow-regulating system can
6 be modular and employed in different vehicles with various shock-
7 absorption performances. Since there will be no sudden jolts when
8 shifting between the hard and soft phases and vice versa, riding
9 comfort will be considerably improved.

10
11 Various embodiments of the present invention will now be
12 specified by way of example with reference to the accompanying
13 drawing, wherein

14
15 Figure 1 is a schematic illustrating how a dashpot can be
16 regulated in accordance with a single-chamber principle,

17
18 Figures 2 through 11 are schematics illustrating various other
19 approaches to regulation in accordance with the single-chamber
20 principle,

21
22 Figures 12 and 13 are schematics illustrating how a dashpot can
23 be regulated in accordance with a resilient-chamber principle and
24 with a two-chamber principle, and Figure 14 is a schematic
25 illustrating regulation inside a dashpot cylinder.

1 The figures illustrate hydraulic circuitry specific to various
2 dashpots. Each dashpot includes a piston 3 mounted on the end of
3 a piston rod 2 and traveling back and forth inside a cylinder 1.
4 A reservoir 4 contains a compressed gas that compensates for the
5 volume of hydraulic fluid displaced by piston 3. Reservoir 4 can
6 be integrated into the dashpot.

7
8 Figure 1 illustrates the hydraulic circuitry for a dashpot in
9 accordance with the present invention. The dashpot includes two
10 hydraulically parallel regulating valves 5 and 6. Hydraulically
11 paralleling both regulating valves 5 and 6 is a very narrowly
12 constricted bypass valve 7, which can alternatively be integrated
13 into one or both regulating valves. Bypass valve 7 provides a
14 minimal passage for the hydraulic fluid and accordingly prevents
15 the dashpot from being entirely blocked while regulating valves 5
16 and 6 are closed. When closed, regulating valves 5 and 6 provide
17 continuous regulation of the two phases and, when closed, allow
18 the fluid to flow. Regulating valve 5 regulates the flow while
19 piston 3 is traveling in the compression direction and regulating
20 valve 6 regulates it while the piston is traveling in the
21 decompression direction. The rate of flow depends on the one hand
22 on the difference between the pressure in an upper chamber 8 and
23 that in a lower chamber 9, the two chambers being separated by
24 piston 3, and on the other hand on the cross-section of the
25 passage through regulating valves 5 and 6 as dictated by flow
26 controls like those known from German Patent 10 040 518.

Figure 2 illustrates another embodiment of the circuitry illustrated in Figure 1. In this embodiment, fluid can flow through both regulating valves 5 and 6 from either end as long as they are open, and the operative direction is prescribed by external checkvalves 10 and 11.

Figure 3 illustrates an advanced version of the circuitry illustrated in Figure 2. It employs spring-loaded checkvalves 12 and 13 instead of the external checkvalves 10 and 11. Such checkvalves will open to an extent that depends on the difference in pressure between chambers 8 and 9. The type of springs employed determine the intended performance curve of the dashpot in both compression and the decompression phases.

Figure 4 illustrates an advanced version of the circuitry illustrated in Figure 3. It includes a valve assembly 18 comprising unregulated spring-loaded checkvalves 16 and 17 that parallel regulated spring-loaded checkvalves 12 and 13. Checkvalves 16 and 17 parallel each other hydraulically and operate independently in both the compression and the decompression phases. Valve assembly 18 can be integrated into piston 3 and acts as a standard spring loaded piston. The performance curve for valve assembly 18 is set to "hard" and that of regulated spring-loaded checkvalves 12 and 13 to "soft". Regulating valves 5 and 6 can accordingly now switch independently of each other and continuously back and forth between hard and soft in both the compression and the

decompression phases. In addition to bypass valve 7, bypass valves 19 and 20 can be introduced paralleling spring-loaded checkvalves 12 and 13.

This embodiment ensures constantly reliable driving performance even when the electricity or electronics fail. In such an event, regulating valves 5 and 6 will substantially close, and continued operation of the dashpot will be ensured by the mechanical action of the spring-loaded checkvalves 16 and 17 in valve assembly 18 at a hard performance curve, preferably within piston 3, that is.

The embodiment illustrated in Figure 5 lacks the regulated spring-loaded checkvalves 12 and 13 employed in the embodiment illustrated in Figure 4. This embodiment is an advanced version of the regulable dashpot illustrated in Figure 1, employing a parallel valve assembly 18 like that in the version illustrated in Figure 4. The bypass valve can also be eliminated.

Figure 6 illustrates an alternative to the embodiment illustrated in Figure 5. Paralleling a valve assembly 18 that comprises unregulated spring-loaded checkvalves 16 and 17 with their hard performance curve are two similar spring-loaded checkvalves 12 and 13 with a soft performance curve. Checkvalves 12 and 13 can be brought into play by way of associated hydraulic switches 21 and 22, allowing a soft performance curve to be introduced while piston 3 is traveling in either the compression or the decompression direction. Paralleling these are two parallel one-

1 way checkvalves 23 and 24 with a soft performance curve that can
2 be actuated and regulated by a regulating valve 25. This
3 circuitry again allows the shock-absorption performance curves to
4 be established anywhere between hard and soft independently of
5 each other as desired with the piston traveling in either
6 direction.

7
8 Circuitry similar to that illustrated in Figure 6 can be attained
9 as illustrated in Figure 7. The soft checkvalves 12 and 13 in
10 this embodiment are provided with a two-to-three way valve 26
11 instead of two individual switching valves.

12
13 Figure 8 illustrates another alternative embodiment. A valve
14 assembly 27 comprises two spring-loaded checkvalves 28 and 29,
15 each permitting the flow in a direction opposite that of the
16 other. Checkvalves 28 and 29 have a soft performance curve and
17 are alternately controlled by a two-to-three way valve 30. A
18 flow-regulating valve 31 continuously opens or closes a parallel
19 hydraulics line 32. A constricted bypass valve 33 ensures minimal
20 unimpeded flow.

21
22 Figure 9 illustrates an advanced version of the of the embodiment
23 illustrated in Figure 8. Upstream of flow-regulating valve 31 is
24 a valve assembly 34 comprising two spring-loaded opposed-flow
25 checkvalves 35 and 36. Checkvalves 35 and 36 also have a soft
26 performance curve, although this curve can be varied between hard
27 and soft. Bypass valve 33, which, like the one illustrated in

1 Figure 8, can parallel flow-regulating valve 31, two-to-three way
2 valve 30, and/or the two series comprising a regulation-and-
3 switching valve and checkvalves 35 and 36 or checkvalves 28 and
4 29, again ensures minimal flow as long as two-to-three way valve
5 30 and flow-regulating valve 31 are closed.

6
7 Figure 10 also illustrates an advanced version of the embodiment
8 illustrated in Figure 8. This version includes, paralleling the
9 components illustrated in Figure 8, another, unregulable, valve
10 assembly 37 comprising spring-loaded opposed-flow checkvalves 38
11 and 39. Checkvalves 38 and 39 have a hard performance curve and
12 can preferably be integrated into the piston in the form of
13 standard cupspring-loaded valves.

14
15 Figure 11 illustrates another advanced version of the embodiment
16 illustrated in Figure 8. It includes a valve assembly 27
17 comprising spring-loaded opposed flow checkvalves 28 and 29 with
18 a soft performance curve, their direction of flow being reversed
19 by a two-to-three way valve 30. The flow-regulating valve 31 in
20 this embodiment, however, parallels valve 30, constantly
21 maintaining the valve assembly 27 comprising checkvalves 28 and
22 29 in series with the latter. This embodiment also includes a
23 constricted bypass valve 33 that ensures minimal flow.

1 The flow-regulating assembly 40 represented by the dot-and-dash
2 lines in Figures 1 through 11 is depicted in the form of a
3 preferably self-contained block 41 in Figures 12 and 13. Flow-
4 regulating block 41 can also communicate with valve assembly 18,
5 27, 34, or 37.

6
7 The flow-regulating block 41 represented in Figure 12 is
8 hydraulically interposed between lower cylinder chamber 9 and
9 pressure-compensating gas reservoir 4.

10
11 Figure 13 illustrates a double-cylinder dashpot with a valve
12 assembly 42 comprising two spring-loaded checkvalves 43 and 44
13 integrated into its piston 3. A bottom valve 46 in the form of a
14 spring-loaded one-way valve is interposed between lower cylinder
15 chamber 9 and a pressure-compensating reservoir represented by
16 the space 45 between the cylinder's walls. The flow regulating
17 assembly is preferably again in the form of a self-contained
18 block 41 located outside the dashpot and hydraulically interposed
19 between cylinder chambers 8 and 9.

20
21 The hydraulic switching-and-regulating components in the
22 embodiment illustrated in Figure 14 are integrated, like the
23 components illustrated in Figure 11, into the dashpot's piston 3.

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List of parts

- 1
- 2 1. cylinder
- 3 2. piston rod
- 4 3. piston
- 5 4. reservoir
- 6 5. regulating valve
- 7 6. regulating valve
- 8 7. constricted bypass valve
- 9 8. upper cylinder chamber
- 10 9. lower cylinder chamber
- 11 10. checkvalve
- 12 11. checkvalve
- 13 12. checkvalve
- 14 13. checkvalve
- 15 14. compression spring
- 16 15. compression spring
- 17 16. checkvalve
- 18 17. checkvalve
- 19 18. valve assembly
- 20 19. constricted bypass
- 21 20. constricted bypass
- 22 21. hydraulic switch
- 23 22. hydraulic switch
- 24 23. checkvalve
- 25 24. checkvalve

- 1 25. flow-regulating valve
- 2 26. two-to-three way valve
- 3 27. valve assembly
- 4 28. checkvalve
- 5 29. checkvalve
- 6 30. two-to-three way valve
- 7 31. flow-regulating valve
- 8 32. hydraulics line
- 9 33. constricted bypass valve
- 10 34. valve assembly
- 11 35. checkvalve
- 12 36. checkvalve
- 13 37. valve assembly
- 14 38. checkvalve
- 15 39. checkvalve
- 16 40. flow-regulating assembly
- 17 41. flow-regulating block
- 18 42. valve assembly
- 19 43. checkvalve
- 20 44. checkvalve
- 21 45. intermural space
- 22 46. bottom valve
- 23
- 24